STATE OF CALIFORNIA
DEPARTMENT of TRANSPORTATION

MATERIALS ENGINEERING AND TESTING SERVICES

OFFICE OF RIGID PAVEMENTS and STRUCTURAL CONCRETE

5900 Folsom Boulevard
Sacramento, California 95819

PORTLAND CEMENT BASED FAST-SETTING CONCRETE DEMONSTRATION

District 07
Los Angeles County
Contract Number: 07-181504

September 2001

ACKNOWLEDGEMENTS

The Office of Rigid Pavement and Structural Concrete would like to express its gratitude to the following groups for their participation, assistance and support:

HEADQUARTERS

Division of Maintenance

DISTRICT 07

Maintenance

Construction

Materials Engineering

INDUSTRY

Chumo Construction

Master Builders, Inc.

National Ready Mix

Teichert Ready Mix

Twining Laboratories

Cover photo: Approximately 4 hours and 20 minutes after placement, a loaded ready mix truck was driven onto the slab (see cover photo). No cracks were observed

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INTRODUCTION

The Department currently uses fast-setting concrete to accommodate short working windows, normally at night. The current special provision for fast-setting concrete requires that the concrete reach a flexural strength of 2.8 MPa (400 psi) before opening to traffic. This special provision is a performance specification that allows the contractor to be creative with materials as long as the specified strength is attained. To date, proprietary cements have been used with some degree of success in slab replacement work and in limited structural repairs of bridges. Development of a portland cement based mix that can be placed and opened to traffic in four to six hours has been elusive.

In a continuing effort to demonstrate the effectiveness of fast-setting concrete mixes using non-proprietary cements, Translab and Industry have evaluated several portland cement based concrete mixes. After months of hard work, MasterBuilders, Inc., appears to have developed an admixture system that meets or exceeds the requirement of the aforementioned special provision. With the assistance of Teichert Ready Mix, National Ready Mix, and Chumo Construction, MasterBuilders provided Translab the opportunity to evaluate this mixture by placing three different slabs.

DEMONSTRATION SLABS

On August 28, 2001, the first of two demonstration slabs was placed at Translab. Teichert Ready Mix, under the guidance of MasterBuilders, batched and delivered the experimental mix. The mix consisted of a Kaiser Type II/III cement, a high-range water reducer, an accelerator, and 12.5-mm (½") maximum size aggregate, with a 0.31 w/c ratio. The mix had a 180-mm (7") slump and was very workable. In 4 hours, the test beams had a flexural strength of 2.3 MPa (332 psi) and 2.8 MPa (412 psi) at 6 hours. After 7 days, a flexural strength of 5.0 MPa (732 psi) was obtained.

A second demonstration slab was placed at the National Ready Mix plant in Glendale on September 5 (see Figure 1). The mix consisted of the same high-range water reducer and accelerator, 25-mm (1") maximum size aggregate and a Mitsubishi Type III cement. The mix was delivered in a ready mix truck, had a 125-mm (5") slump and was very workable. At 4 hours, the test beams had a flexural strength of 3.3 MPa (477 psi), the target strength was 2.8 MPa (400 psi).

Figure 1. Demonstration Slab in Glendale.

Approximately 4 hours and 20 minutes after placement, a loaded ready mix truck was driven onto the slab (see cover photo). No cracks were observed.

TRIAL SLAB

On September 14, a trial slab, conforming to the specifications for Project 07-181504, was placed on Interstate 405 during the night. National Ready Mix batched and delivered the concrete and Chumo Construction placed it. The mix design was essentially the same as that of the second demonstration slab. The mix had a slump of 240-mm (9½") and was also very workable.

Figure 2. Placing Concrete for the Trial Slab

Figure 3. Consolidating and Finishing the Trial Slab

Test Beams

Several sets of test beams were fabricated for flexure strength testing. The beams were insulated after fabrication. Testing was performed at 3, 4, 5, 8, and 24 hours after placement. The target strength was 2.8 MPa (400 psi) in 4 hours during nighttime temperatures.

Figure 4. Fabricating Test Beams

The mix was effectively "put to sleep" by retarding the hydration process during transit. The accelerator was added to the mix at the job site.

Table 1. Test Beam Results

Curing Time	Strength, MPa			
	Beam 1	Beam 2	Beam 3	Average
3 Hour	2.90	3.20	2.70	2.95
4 Hour	3.20	3.35	3.50	3.35
5 Hour	3.70	3.75	3.50	3.65
8 Hour	4.30	4.10	4.30	4.20
24 Hour	4.50	4.40	4.50	4.45

Temperatures

Upon placing and finishing the trial slab, the concrete temperature was 28.6°C (83.5°F). About 4 hours later, the concrete temperature peaked at 53.9°C (129°F). Temperatures for the test beams were not recorded.

Figure 5. Initial Concrete Temperature

Table 2. Air and Concrete Temperatures

Time	Air Temperature*, °C (°F)	Concrete Temperature, °C (°F)
0053	17.2 (63.0)	N/A
0111	16.7 (62.1)	28.6 (83.5)
0200	16.7 (62.1)	31.1 (88.0)
0430	N/A	52.8 (127.0)
0530	N/A	53.9 (129.0)
0630	N/A	52.8 (127.0)

*Temperature at Burbank Airport N/A = not available

Encouraged by the test beam results and performance, District 07 has expressed an interest in continuing to use this mix on this project.

CONCLUSIONS

The flexural strengths of the mix met or exceeded the target strength of 2.8 MPa (400 psi) in 4 hours. This blend of chemical admixtures and cement was found to be user-friendly by both the concrete producers and the construction crews placing and finishing the slabs. The mix had good slump, allowed plenty of time to place and finish the slabs, and provided ample time for delivery trucks to be washed out.

The primary application for this mix would be concrete roadway repair and rehabilitation as well as emergency repairs. Because of its high strengths and non-chloride characteristics, the mix could potentially be used for bridge repairs.

With the demonstrated success of this portland cement based fast-setting concrete, it is likely that other admixture suppliers will develop their own similar performing systems and make them available soon.

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